

BJÖRN SALOMON

Deviating variants of *Elymus caninus* (*Poaceae*) in NW Europe

Abstract

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The variation in *Elymus caninus* in NW Europe is briefly discussed. On the one hand, three short-awned taxa described from this area, with the epithets *donianus*, *behmii* and *muticus*, are considered to be conspecific with the long-awned *E. caninus* var. *caninus*. The three taxa represent morphologically deviating populations, which are best treated at varietal level, if desirable to recognize them at all. They are, however, doubtfully distinct from each other. On the other hand, the Icelandic populations of *E. caninus* have been shown to be morphologically, geographically, reproductively and genetically deviating from all other investigated populations of this species. Hence, they are described here as a new species, *E. alopex*. A key to the accepted non-littoral *Elymus* taxa in NW Europe is provided.

Introduction

The Bearded Couch, *Elymus caninus* (L.) L. (*Poaceae: Triticeae*), is a well-known species widely spread in forests and coppices in Europe and parts of western and central Asia. It occurs from subarctic areas in northern Norway and Russia to Spain and Turkey in the south. The western border is on the British Isles and it extends eastwards to the western Siberian lowlands and northern Pakistan (Cope 1982, Hultén & Fries 1986, Melderis 1980, Peschkova 1990). Considering its wide geographical and ecological amplitudes, a considerable genetic variation was expected to reside within this species, and this was confirmed by using molecular markers (Sun & al. 1999). The morphological variation, in contrast, is moderate and does not seem to be greater than in many other widespread *Elymus* species. Throughout most of the distribution area, *E. caninus* is fairly distinct and easy to separate from all other *Elymus* species. The greatest delimitation problems appear in Central Asia, where hybridization and possibly introgression with several other species seem to occur (pers. obs.). In NW Europe it rarely causes any determination problems, but also here occur atypical variants. In fact, some are so deviant that they were previously treated as separate species.

Short-awned variants

In Scotland, specimens with short-awned lemmas and large glumes have been referred to as *Elymus donianus* (F. B. White) Á. Löve & D. Löve. This taxon was described from Ben Lawers

and for many years it was only known from this mountain range (Melderis 1950). Later, Raven & Walters (1954) reported that *E. donianus* is also locally frequent in the Inchnadamph area, where it grows together with *E. caninus*, and they reported the occurrence of intermediate plants as well. The putative hybrid, however, did not display any aberrant pollen development, as is the usual case in interspecific *Elymus* hybrids. Furthermore, Melderis & McClintock (1983) reported, although without giving any details, that artificial hybridizations between *E. caninus* and *E. donianus* gave rise to fertile, intermediate progenies and that the distinguishing characters segregated in subsequent generations. Consequently, the taxon *donianus* has been reduced to varietal rank, i.e., *E. caninus* var. *donianus* (F. B. White) Jaaska, and this has been accepted in modern British Floras (cf. Stace 1997).

An apparently parallel case is found in Jämtland, Sweden. In Hylander (1953), A. Melderis described a new species, *Roegneria behmii* Melderis, which also differs from *Elymus caninus* in having short-awned lemmas and in some glume characteristics. This species is only known from the type locality, a south exposed precipice of the small mountain Flinten in Hotagen parish. Nordenstam (1972) made a thorough morphometric study of this taxon and found intermediate plants that were fully fertile. He concluded that this taxon was not morphologically distinct from *E. caninus* and that it probably represents a local population adapted to a drier and more open habitat than is normal for *E. caninus* in that area. Hence, this taxon is better treated at a varietal level, if recognized at all. The corresponding combination in *Elymus* is then *E. caninus* var. *behmii* (Melderis) Jaaska.

Whereas *Elymus caninus* var. *donianus* s.str. and var. *behmii* are geographically restricted, the taxon "*muticus*" has been reported as having a much wider distribution in central and northern Europe (Melderis 1980). This taxon was first described from the town Karlstad in Värmland, central Sweden, as *Agropyron caninum* f. *muticum* Holmb. (Holmberg 1926). However, since the length of the lemma awn is a character that displays simple genetic segregation (Salomon & Agafonov, unpubl.) and short-awned individuals seem to occur independently here and there throughout the whole distribution range (Melderis 1980), they could be regarded as local mutant individuals rather than a separate taxon. Still, in at least two regions "*muticus*"-dominated populations are present, namely, along the river Klarälven in Värmland, Sweden (Hård av Segerstad 1943), and along the river Tana and its tributary Karasjok, in northern Norway (Sivertsen 1966). Hitherto, only material from Klarälven has been investigated experimentally in detail. Díaz & al. (1999) compared a "*muticus*" population from Karlstad, Värmland, with populations of *E. caninus* from Norway, Denmark, Sweden, Finland, Italy, Russia, Pakistan, and China. Based on isozyme markers, "*muticus*" could not be separated from *E. caninus* in the cluster analysis (UPGMA) or the principal component analysis (PCA) and it possessed no unique banding patterns. This further supports the hypothesis that there is little genetic differentiation between "*muticus*" and *E. caninus*.

However, in a checklist of the vascular plants of Sweden, Karlsson (1998) suggested that "*muticus*" would be identical with the Siberian species *E. macrourus* (Turcz. ex Steud.) Tzvelev, but this was rejected by Díaz & al. (1999) based on isozyme data (see Díaz & al. 1998) and a morphological comparison with material used in a study of the *E. macrourus* complex from Siberia by Agafonov & al. (1996). Furthermore, hybrids between "*muticus*" and normal *E. caninus* from Norway and Sweden were highly fertile, whereas hybrids between "*muticus*" and *E. macrourus* from the Altai Mountains, Russia, were sterile (unpublished data). This suggests the absence of reproductive barriers between "*muticus*" and surrounding *E. caninus* populations. Thus, also "*muticus*" seems to represent a local mutant variant of *E. caninus*, possibly adapted to more open habitats than is usual for *E. caninus* (cf. Hård av Segerstad 1943). Hence, varietal rank, i.e. *E. caninus* var. *muticus* (Holmb.) T. Karlsson, may be appropriate as indeed suggested in the updated version of Karlsson's checklist (Karlsson 2003).

Two populations of the Norwegian "*muticus*" are currently under study. Preliminary data suggest that they are genetically deviating from the Swedish "*muticus*" populations. Hence, there seems to be yet another short-awned taxon in this complex. However, it is too early to

evaluate the status of this new taxon and it is more than likely that interspecific hybridization(s) may have been involved in its origin. The Norwegian populations included in this study were growing together with *E. mutabilis* (Drob.) Tzvelev, *E. fibrosus* (Schrenk) Tzvelev and *E. caninus* var. *caninus*.

It is questionable whether the different short-awned variants of *Elymus caninus* are morphologically distinct from each other. However, a detailed study of the morphological variation and comparison between the different short-awned variants was far beyond the scope of this investigation. As noted above, it seems that the short-awned individuals or populations occur independently and, hence, they should not be considered a single taxon. The foremost reason for accepting these taxa at all is their striking morphological appearance and the possible ecological differentiation. This needs, however, to be confirmed by detailed studies.

The Icelandic variant

Elymus caninus has been recorded from several localities in Iceland, too, with a distribution centre in the north-central part of the island (Kristinsson 1987). Morphologically, all Icelandic plants seen (nine populations cultivated and the specimens in the Copenhagen University Herbarium) are very uniform and clearly different from the closest populations in the British Isles and Scandinavia. The most distinguishing feature of the Icelandic populations is that they have erect spikes that are very dense and unilateral. Individuals of *E. caninus* with somewhat denser and erect spikes can be found throughout the total distribution area, but never as pronounced as in the Icelandic plants. The Icelandic populations thus obviously form a unique morphological variant. Furthermore, the Icelandic populations have no morphological or genetic connections to the *E. trachycaulus* (Link) Gould ex Shinners complex in Greenland and the North American continent (pers. obs., Sun & al. in prep.). Hence, it appears that this variant is endemic to Iceland.

Icelandic populations have been thoroughly studied during the last decade by various methods. Kostina & al. (1998) reported that they possess a unique seed storage protein variation, as compared to *E. caninus* accessions from Scandinavia, Central Europe, Turkey, Russia, Kazakhstan and China. The prolamine banding-patterns differ considerably, especially in the 38-40 kD range, and the Icelandic plants possess a unique high molecular weight gluteline subunit. They suggested that the Icelandic plants might be misclassified as *E. caninus*.

Allozyme studies have also shown that the Icelandic populations differ considerably in their allele frequencies at polymorphic loci and also possess specific genotypes not present among the 48 Eurasian populations investigated (Díaz & al. 1999). For example, in the enzyme system aconitase, the allele *Aco-4(a)* was only present in some of the Icelandic populations while all other *Elymus caninus* populations were monomorphic for the *Aco-4(b)* allele. The allele *Aco-4(a)* is characteristic for the complex of *E. alaskanus* (Scribn. & Merr.) Á. Löve and this could be an indication that introgression has occurred from this species complex.

A study of the genetic diversity in *Elymus caninus* using Random Amplified Polymorphic DNA (RAPD) and Simple Sequence Repeat (SSR) marker variations also indicated that the Icelandic populations deviate from all other populations of *E. caninus* (Sun & al. 1999). The cluster analyses consistently grouped the Icelandic populations together and the principal coordinate analysis markedly separated them from all other *E. caninus* populations. These results suggest that the Icelandic populations are genetically deviating from all continental populations.

In crossing experiments, it was found that strong reproductive isolation barriers existed between the Icelandic populations and *E. caninus* populations from Scandinavia and Siberia, respectively, and most F₁ hybrids were completely sterile (Kostina & al. 1998, Díaz & al. 1999). However, at least in some hybrids a few seeds could be found and the fertility could be restored in subsequent generations by directed selection. Thus, the degree of post-zygotic isolation between the Icelandic populations and continental *E. caninus* is equivalent to or even stronger than that between continental *E. caninus* and *E. mutabilis*, which are always treated as separate species (Agafonov & Salomon 2002).

These studies, taken together, strongly suggest that the Icelandic populations are morphologically, geographically, genetically and reproductively isolated from all other populations of *Elymus caninus*, and thus are better treated as novel species, *E. alopex*, which is described below.

The variant *Stefanssonii*

Roegneria doniana var. *stefanssonii* Melderis was described as being from Valþjófsstaðabrekkur in Norður-Thingeyjarsýsla, northern Iceland by Melderis (1950). However, the correct locality should be Valþjófsstaðabrekkur in Fljótsdalshéra, Norður-Múlasýsla, eastern Iceland (Kristinsson, pers. comm.). This taxon was later transferred to *Elymus* by Löve & Löve (1976), as *E. trachycaulus* subsp. *stefanssonii* (Melderis) Á. Löve & D. Löve. Under this name it is still treated in the latest regional Floras (Mossberg & Stenberg 2003, Jonsell & Karlsson 2004). However, it is notable that neither Melderis (1980) nor Kristinsson (1987) include “*stefanssonii*” in their flora treatments; presumably they did not consider it worthy recognition. Melderis & McClintock (1983), when discussing *E. caninus* var. *donianus* in Scotland, included Iceland in a list of other countries also having short-awned variants of *E. caninus*. I interpret this as an allusion to “*stefanssonii*” although this taxon is not explicitly mentioned in their paper.

A brief examination of the holotype in the Copenhagen University Herbarium (C) revealed that “*stefanssonii*” differs from *Elymus alopex* in several morphological characters indicating that it is not a muticous variant of this species. The spikes are looser and distinctly distichous, the lemmas are short-awned and less hairy, and the glumes are less hairy and adaxially glabrous. In most respects “*stefanssonii*” is more similar to *E. repens* (L.) Gould than to *E. alopex*. However, the anthers are much smaller than in *E. repens* and obviously sterile as well. The tentative conclusion is that “*stefanssonii*” refers to an abnormally developed plant of *E. repens* or possibly the hybrid *E. repens* × *E. alopex*. To resolve this question, more and better developed specimens and preferably living material need to be examined.

Taxonomy

Elymus caninus (L.) L., Fl. Suec., ed. 2: 39. 1755 ≡ *Triticum caninum* L., Sp. Pl.: 86. 1753.

Elymus caninus var. *donianus* (F. B. White) Jaaska in Eesti NSV Tead. Akad. Toim., Biol. 23: 5. 1974 ≡ *Agropyron donianum* F. B. White in Proc. Perthsh. Soc. Nat. Sci. 1: 41. 1893.

Elymus caninus var. *behmii* (Melderis) Jaaska in Eesti NSV Tead. Akad. Toim., Biol. 23: 5. 1974 ≡ *Roegneria behmii* Melderis in Bot. Not. 1953: 358. 1953.

Elymus caninus var. *muticus* (Holmb.) T. Karlsson in Svensk Bot. Tidskr. 97: 194. 2003 ≡ *Agropyron caninum* f. *muticum* Holmb. in Bot. Not. 126: 185. 1926.

Elymus alopex B. Salomon, **sp. nov.**

Holotype: Iceland, Þingeyjarsýsla, east of Akureyri, Fnjóskadalur, 2.5-3 km S of Þórðarstaðir. Shrubland with *Betula nana* and *Salix* spp., 9.9.1994, R. von Bothmer & M. Ørgaard Is9404A (LD).

Affinis *Elymo canino* sed ab hac specie differt spicis arrectioribus, densioribus et unilateralibus.

Tufted perennial. *Culms* glabrous or sparsely covered with short hairs below the nodes, c. 0.6-0.8 m tall and up to 5 mm wide. *Nodes* pale green to dark purple, glabrous to densely short-hairy. *Leaf blades* flat, up to 200 × 5-7 mm broad, adaxial side long-hairy, abaxial side glabrous but minutely scabrous. *Leaf sheaths* glabrous. *Spikes* dense and unilateral, erect, 70-110 × c. 5 mm, green but with a distinct purple tinge, with 13-23 spikelets; rhachis internodes 4.5-5.5 × 1 mm, with setulose margins, glabrous and smooth on the back. *Spikelets* sessile, lanceolate, 12-14 mm long, with 2(-4) fully developed and one rudimentary floret. *Glumes* subequal, lanceolate and slightly asymmetric, gradually narrowed into a 2.5-5.5(-7) mm long awn, margin scarios, white or purple coloured, the lower glume 8-9 × 1.5 mm, the upper glume 8-10 × 1.5-2 mm, with 3(-4) prominent

nerves, abaxial side scabrous to short-hairy, especially prominent on the nerves, adaxial side ± densely covered with long to short hairs. *Lowest lemmas* ± symmetrically lanceolate, 10.5-12 × 1.5-2 mm, tapering into a straight, flexuous or slightly bent, scabrid, 8-11.5(-15) mm long awn, 5-nerved, the abaxial side sparsely short-hairy at the base, along the sides and towards the tip, in the middle almost glabrous; callus densely setulose. *Paleas* 9-11 × 1.5 mm, keels with small cilia along the entire to ½ of its length from the tip (about 50-100 cilia along each keel), with scattered hairs between the keels, about equal in length to the lemma; lowest rhachilla internode 1.5-2 mm long, covered with protruding hairs. *Anthers* small, c. 2 mm long, yellow.

Etymology. – The species epithet is an adoption of the generic name of the Arctic Fox.

Distribution. – Endemic to Iceland. It is relatively common in the north-central parts of the island and it has scattered occurrences in the eastern parts as well as two isolated records from the south (cf. map in Kristinsson 1987).

Habitats. – Shrubland and woodland with birch and willow species and sometimes in ditches along roads.

Chromosome number. – Tetraploid, $2n = 28$, recorded from seed accessions H10360 [= type locality], H10564, H10565, and H10566.

Specimens measured. – R. von Bothmer & M. Ørgaard Is9403, Is9404A, Is9404B, Is9405, Is9406, Is9407, Is9408A, Is9408B (all LD).

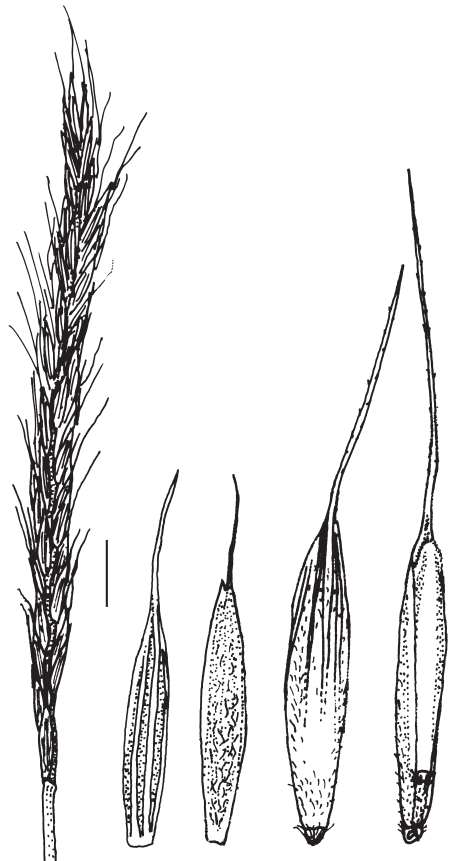


Fig. 1. *Elymus alopecurus* B. Salomon – spike, lower glume (abaxial side), upper glume (adaxial side), first floret (abaxial side) and second floret (adaxial side). – Scale bars = 1 cm. Drawn from cultivated material of seed accession H10360.

Key to the non-littoral *Elymus* taxa in NW Europe

- 1 Plants loosely tufted, with long creeping rhizomes; glumes disarticulating with the florets at maturity; anthers long; hexaploid ($2n = 42$) *Elymus repens* (L.) Gould
- Plants loosely to densely tufted, without long rhizomes; glumes persistent on the rachis at maturity; anthers short; tetraploids ($2n = 28$) 2
- 2 Glumes oblanceolate to obovate, with broad scarious margins, broadest towards the apex . . . 3
- Glumes lanceolate to ovate, usually with narrow scarious margins, broadest at about the middle 4
- 3 Lemma hairy *Elymus alaskanus* subsp. *islandicus* (Melderis) Á. Löve & D. Löve
- Lemma glabrous *Elymus alaskanus* subsp. *subalpinus* (Neuman) Á. Löve & D. Löve
- 4 Lemma scaberulous to minutely hirsute all over *Elymus mutabilis* (Drobov) Tzvelev
- Lemma glabrous and smooth on the back but often scabrid or with scattered hairs along the sides and near the tip 5
- 5 Lemma callus with long protruding hairs; spike arcuate
- *Elymus fibrosus* (Schrenk) Tzvelev

- Lemma callus hirsute to minutely hairy; spike erect or somewhat curved at the flowering stage 6
- 6 Spike dense and erect, distinctly unilateral *Elymus alopecurus* B. Salomon
- Spike rather dense to loose and typically curved at seed maturity, distichous or sometimes slightly unilateral *Elymus caninus* (L.) L.

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Address of the author:

Björn Salomon, Department of Crop Science, Swedish University of Agricultural Sciences, PO Box 44, SE-230 53 Alnarp, Sweden; e-mail: bjorn.salomon@vv.slu.se